Full paper

Sains Humanika

Best Practices in STEM Education for Preschool Children: A Case Study in Malaysia

Azam Ghazali[a*], Zakiah Mohamad Ashari[a], Joanne Hardman[b], Romarzila Omar[c], Sri Wiji Handayani[d]

[a]School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia
[b]School of Education, Faculty of Humanities, University of Cape Town, Rondebosch, Cape Town, 7700, South Africa
[c]Department of Early Childhood Education, Sultan Idris Education University, 35900 Tanjong Malim, Perak, Malaysia
[d]TK Labschool UNNES, Jalan Menoreh Tengah, Sampangan, Kecamatan Gajahmungkur, Kota Semarang, Jawa Tengah 50232, Indonesia

*Corresponding author: muhammad.nur.azam@graduate.utm.my

Article history: Received: 07 August 2023 Received in revised form: 31 October 2023 Accepted: 01 December 2023 Published online: 31 December 2023

Abstract

Previous research has demonstrated that since 1967, the Malaysian government has set a target percentage rate of 60:40 for student involvement in the science stream compared to literature. This ratio policy has been followed throughout the national school system ever since. However, such a ratio appears to be impossible to maintain year after year. Therefore, the empowerment of science education needs to be explored from an earlier. This study was conducted to *(i)* explore best practices in Early Science in relation to the implementation of STEM activity in preschool; *(ii)* explore best practices in Early Mathematics in relation to the implementation of STEM activity in preschool; *(iii)* explore technology-assisted teaching tools in relation to the implementation of STEM activity in preschool; and *(iv)* explore engineering activity in relation to the implementation of STEM activity in preschool. This qualitative study employed a case study approach, with data triangulation based on interviews, observations, and document analysis serving as the exploratory method. This study was conducted independently in three Malaysian preschools in Perak and Selangor respectively, with four teachers and 39 children participating as study participants. ATLAS.ti version 8 software was used to generate, arrange, and organise the themes from the three research instruments described utilizing descriptive analysis with the flow of coding processes. The results show that there are nine STEM education best practices, with play-based learning being identified by participants the most frequently. Thus, this study's most significant contribution is the potential to bridge the gap between the Ministry of Education Malaysia's goals to advance STEM education globally, starting in the early years.

Keywords: STEM education, Best Practices, 21st Century Learning, Learning and Facilitation Process, Preschool Children

Absrak

Kajian-kajian lepas telah menunjukkan bahawa sejak tahun 1967, kerajaan Malaysia telah menetapkan kadar peratusan sasaran 60:40 untuk penglibatan pelajar dalam aliran sains berbanding sastera. Dasar nisbah ini telah dipatuhi sepanjang sistem persekolahan kebangsaan sejak itu. Walau bagaimanapun, ketetapan nisbah ini nampaknya mustahil untuk dikekalkan tahun demi tahun. Oleh itu, pemerkasaan pendidikan sains perlu diterokai dari peringkat lebih awal agar. Jadi, kajian ini dijalankan untuk (i) meneroka amalan terbaik dalam Sains Awal berhubung dengan pelaksanaan aktiviti STEM di prasekolah; (ii) meneroka amalan terbaik dalam Matematik Awal berhubung dengan pelaksanaan aktiviti STEM di prasekolah; (iii) meneroka alat pengajaran berbantukan teknologi berhubung dengan pelaksanaan aktiviti STEM di prasekolah; dan (iv) meneroka aktiviti kejuruteraan berhubung dengan pelaksanaan aktiviti STEM di prasekolah. Kajian kualitatif ini menggunakan pendekatan kajian kes, dengan triangulasi data berdasarkan temu bual, pemerhatian, dan analisis dokumen sebagai kaedah penerokaan. Kajian ini dijalankan secara bertujuan di tiga prasekolah Malaysia masing-masing di Perak dan Selangor, dengan empat orang guru dan 39 kanak-kanak mengambil bahagian sebagai peserta kajian. Perisian ATLAS.ti versi 8 digunakan untuk menjana, menyusun dan menyusun tema daripada tiga instrumen kajian yang diterangkan menggunakan analisis deskriptif dengan aliran proses pengekodan. Keputusan menunjukkan terdapat sembilan amalan terbaik pendidikan STEM, dengan pembelajaran berasaskan permainan dikenal pasti oleh peserta paling kerap. Justeru, sumbangan paling signifikan kajian ini adalah potensi untuk merapatkan jurang antara matlamat Kementerian Pendidikan Malaysia untuk memajukan pendidikan STEM secara global, bermula pada tahun-tahun awal.

Kata kunci: Pendidikan STEM, Amalan Terbaik, Pembelajaran Abad Ke-21, Proses Pembelajaran dan Pemudahcaraan, Kanak-kanak Prasekolah

1.0 INTRODUCTION

Education is a continual process for every individual from infancy to their chronological age. Education is the predominant factor to human capital, the economy, and national development, and it serves as a standard for a country's progress as well as the outcome of world-class educational achievements such as those in Finland, Switzerland, and Belgium (Razak, 2017). As a result, practically all countries throughout the world are making an effort to provide excellent educational opportunities for the purpose of a future viable generation. According to the National Education Philosophy, education in Malaysia is a continuous effort to develop each individual's potential comprehensively from every point of view in order to produce a society that is knowledgeable, skilled, noble, and responsible for the well-being of themselves and the country (MOE, 2019). The process of developing the education system in this country is ongoing, and the government has also launched the Malaysian Education Development Plan 2013-2025 Transformation Programme (MOE, 2013). The goal of this plan is to make significant reforms to the country's whole education system that are required in the twenty-first century. Indeed, the National Transformation Idea 2050 (TN50) will fundamentally alter the national education system by the year 2050 (Ministry of Housing and Local Governance Malaysia, 2017).

To ensure that the national education system produces high-quality graduates for society, an action should be taken at the earliest possible stage, which is preschool education (Abdul Rahman, 2015). As a result, the government has empowered the education system in Malaysia, beginning with preschool education, in order to achieve the overall advancement of the national education system. In the 2014 Budget, the government additionally earmarked RM530 million to develop 93 preschools as well as several other preschool programmes and services (Ministry of Finance Malaysia, 2014) and recently the government allocated RM188 million for early childhood education under the Community Development Department (KEMAS) through the presentation of 2023's Budget (Ministry of Finace Malaysia, 2022). The intended purpose of this government funding is to raise the number of preschool children in the country who receive quality and ongoing early education regardless of background, race, religion, or place of living (urban or rural). Interestingly, in Malaysia, the early childhood education system is divided into two levels: nursery and preschool. Children aged four and under are placed in a nursery, often known as a Childcare Centre. Meanwhile, children aged four to six are enrolled at kindergarten or preschool. To ensure children are skilled with the good school readiness skills before entering primary school, the Ministry of Education Malaysia or MOE suggested that their potential should be cultivated holistically and integrated in all aspects as outlined in the National Preschool Standard Curriculum 2017 or known as DSKP 2017 (MOE, 2016). On the other hand, to ensure that children gain valuable and quality experiences in preschool, MOE (2013) emphasized that STEM education at an earlier stage for preschool children through the 2013-2025 Education Development Plan.

Shortly, STEM is a way of thinking through several subjects namely science education, mathematics education, engineering activities, and technology activities based on several practical teaching methods (Sneiderman, 2013). Moreover, the emphasis on STEM education at the preschool, primary, and secondary level through curriculum and extracurricular programs with support from stakeholders is known as STEM education policy and school curriculum alternatives in Malaysia (Mohammud et al., 2020). In addition, MOE (2013) again asserted that the government uses multi-mode learning methods such as blended learning, teacher examining and training, and curriculum development to improve the quality of STEM education. Through an accommodating education system, this is done to increase the quality of children who will become future leaders of the country. In addition, according to Moore et al (2016), why STEM education needs to be promoted to all students because it encourages them to design technology and engineering solutions with already existing designs that can be learned from the failure. Besides that, National Research Council (2011) stated that STEM education is important in ECE settings because it provided teachers with opportunities to encourages their students to participate in the activities and programs related to prior knowledge, interests, and experiences. On the other hand, their ability to solve problems, think critically and logically, and to cultivate psychology traits like curiosity, creativity, perseverance, teamwork, and communication all depend on receiving a STEM education (Isabelle & Valle 2016; Lange et al. 2019). Because STEM education offers interesting, realistic learning experiences to children of every stage of development, it is imperative that children be exposed to it from an early age (Pantoya et al, 2015).

Providing children with the chance to participate actively in the classroom will make them even more fascinating. Nonetheless, educators must take a more active role in providing students with engaging and dynamic learning experiences. So, when carrying out STEM activities, the aspect of creativity should be emphasized so that children may understand the topic better and more clearly (Amran et. al 2021). Furthermore, to ensure that learning and facilitation process (LFP) becomes more fascinating, STEM teachers should avoid traditional learning (Mohd Hawari & Mohd Noor, 2020) such as giving many exercises, explanations in chalk, and re-copying what the teacher wrote. Factually, MOE (2016) has offered basic guidelines for teachers to be more prepared in planning and implementing STEM activities in the classroom to ensure that instructors acquire a broader notion of how they can improve their teaching in STEM activities. This can be supported by statement Adam and Halim (2019) where Malaysian government has taken the effort to build a more competent and professional workforce in STEM education so that the country can realize its goal of generating 60% of scientific stream students vs 40% of literature stream students. As a result, this approach can be successful if exposure to STEM education begins at an early age (Wang et al., 2020), such as nursery and preschool. Together, these initiatives can support children's understanding of STEM foundations (Demir & Kermani, 2017) and cultivate an enthusiasm for the subject for when they get to higher education (Campbell et al., 2018). These efforts benefit every stakeholder concerned, particularly children, because, according to the implications of a study conducted by Margot and Kettler (2019), STEM-related activities are the major and genuine key to assessing children's abilities and progress because they do take part in high quality education (National Science Foundation, 2018). As a result, having teachers who are skilled at transmitting STEM knowledge is imperative to fostering STEM competencies and appropriate dispositions in every child (Murphy et al., 2019). Although there are a few major obstacles in implementing STEM activities, such as Mathematics and Science teachers having limited time to carry out STEM activities and a lack of materials to carry out more interesting activities (Rahayu et al., 2018), teachers still have a responsibility to provide meaningful experiences for children to gain knowledge through STEM education (Early Childhood STEM Working Group, 2017).

■2.0 LITERATURE REVIEW

Based on earlier research, it has been determined that STEM education is a seriously debated subject among academics, educators, and policymakers. In recent educational disputes, STEM education has grown in popularity. STEM education has become increasingly popular in recent educational debates. It has become an important topic in various fields, both research and industry. There is no doubt that the idea of making Science, Engineering, Mathematics, and Technology (STEM) relevant, whether integrated or not, has influenced many educational policies and has been a research topic in the field of education (Johnson et, al., 2020). It has emerged as a significant subject in many disciplines, including industry and research. Without a doubt, the notion of making Science, Engineering, Mathematics, and Technology (STEM) relevant has affected many educational strategies and served as a subject of research in the field of education, whether it is integrated or not (Johnson et al., 2020). The implementation of STEM in teaching and learning in Malaysia begins when MOE launched the Education Development Plan Malaysia (PPPM 2013-2025) on 6 September 2012 (Jekri & K Han, 2020).

Although STEM learning is a hot topic to be discussed by many behalf, the implementation of STEM activities in Malaysia is still not given much attention. The MOE (2013) adds more that there are few factors that cause the transmission of enrollment and the quality of student outcomes in STEM. Firstly, lack of awareness and skills in STEM among teachers. Secondly, STEM subject is considered difficult, the content of curriculum is too tight, teaching and learning quality is not consistent and available infrastructure is not enough and old. In fact, there are some schools that have not been implementing STEM activities for the last few years. The best way to ensure that STEM education becomes compulsory subject in schools is the higher education like the State Department of Education to conduct any STEM-related courses. Looking directly to the empowerment of STEM education in Malaysia, according to Adam and Halim (2019), starting with Inquiry-Based Science Education (IBSE) in 2018, teachers from all over Malaysia have undergone courses and training related to STEM activities that are suitable to be implemented in schools. This effort continues with Inquiry-Based Mathematics Education (IBME) in 2019. STEM has been incorporated into the Malaysian curriculum since 2017, beginning with the Secondary School Standard Curriculum (Curriculum Development Division, 2016). This is supported by the findings of the Misdi et al., (2019) study, which found that STEM teachers use fewer methods of innovation during the teaching session.

2.1 Related Theories and Framework to the Implementation of STEM Education in Preschool

To ensure the empirical and theoretical rigour of this study, researchers must establish a connection between the best practices adopted by teachers and the application, use, or reference of relevant ideas. Figure 1 below illustrates the correlation between theoretical concepts and optimal methods in the execution of STEM activities, involving the active involvement of both students and teachers within the classroom setting.

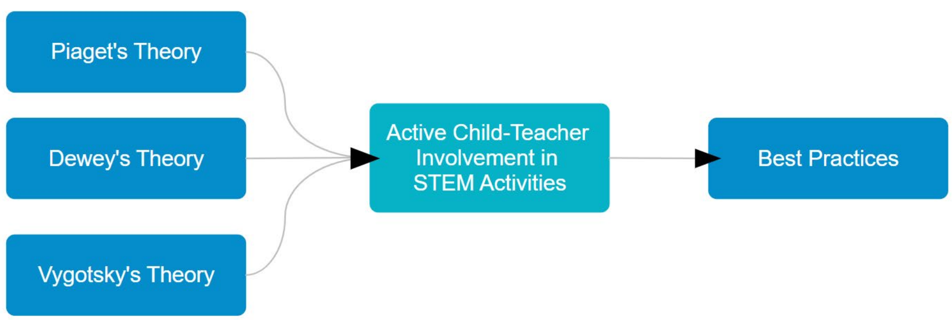

Figure 1 Theory Framework

2.2 Jean Piaget's Theory and Stages of Cognitive Development

The important theory of this research is Jean Piaget's theory. This theory becomes a guideline to elaborate between the importance of the environment in giving meaningful experience to children when they are learning in preschool or preschool about STEM education. One of the most well-known hypotheses on the cognitive development of children was put forth by Jean Piaget in the previous century. For children, Piaget postulated four phases of cognitive development: sensorimotor, preoperational, concrete operational, and formal operational (Babakr et al, 2019). Nevertheless, many cognitive abilities in infants emerge earlier than predicted by Piaget's hypothesis, according to studies. However, the change from one stage to another is supported by several other internal actions. As we know, there are four stages of development in the theory of Jean Piaget. However, the change from one stage to another is supported by several other internal actions. The cognitive ability of children changes qualitatively as they progress from one stage to the next (Sigelman & Rider, 2012).

Piaget emphasized four stages of cognitive development which are sensorimotor stage, pre-operational stage, concreate operational stage, and formal operational stage (Moreno, 2010). Learning had previously been conceptualized primarily in terms of behavioral principles and association processes, whereas cognitive development emerged from the cognitive revolution, the revolution in psycholinguistics, and, particularly, Piaget's work on children's reasoning about a wide range of topics such as space, time, causality, morality, and necessity (Piaget, 1963). Specifically, according to Buchanan (2012), a child's growth in every facet of their development is dependent on their development. Along with their development, the usage of play can have a significant impact on all aspects of a child's development. This can be supported by the statement of Mitleer and Ginsburg (2012), which they stated that active play is so important to a child's development that it could be claimed that it should be included in the definition of childhood."

2.3 Dewey's Educational Theories

The selection of John Dewey's ideas to empower STEM Education at the school level look really important. Absolutely, the way how educator delivers any knowledge is important, but teacher needs to know what the best way to convey it. Teachers need opportunities to continuously develop their professional competencies and learn about recent developments in the subjects they teach, as well as new didactic approaches, in order to provide high-quality instruction (Richer, Brunner & Richer, 2021). From John Dewey's educational point of view in Telebi (2015), the concepts of democracy and social reform are frequently discussed. It means that the roles of teacher and students are important for the development process. Dewey makes a compelling case for the value of education not merely as a source of topic information, but also as a source of life skills. According to him, the primary goal of education should not be the acquisition of a pre-determined set of abilities, but rather the fulfilment of one's full potential and ability to put such skills to good use. He emphasized that preparing him for the future life entails giving him self-control, it means teaching him in such a way that he will be able to make complete adaptation of his abilities (Dewey, 1897).

According to John Dewey (1986), providing the students with enjoyable learning experiences motivates them to continue learning and this motivation matters just as much as knowledge that is learned. Enjoyable learning will encourage children to continue learning. While there may be some children who are obviously weak in learning, they will also continue to learn because it makes them feel so excited. Dewey stresses the sensitivity of educationists towards learners' guide and mentor. It is therefore responsibility of the teacher to plan positive and constructive environment for the students to create positive and constructive environment for the students so as to create positive educative experiences for them, (Sikandar, 2015). Meaningful learning experience not only gives benefits to children and educators, but it will also give an advantage to the education system in creating quality learning starting from the earlier stage. Preschool and preschool students need to find out the quality in education and teachers need to be more creative to create it.

2.4 Vygotsky's Sociocultural Theory

Next, the third theory that exposes the importance of adults in improving children's development is Vygotsky's Social Cognitive Development. If Piaget explained the importance of four stages in children's development, otherwise Vygotsky explained about the importance of children's thinking zone in affecting of their developments. According to Topçiu and Myftiu (2015), Vygotsky's theory proposes that cognitive development proceeds through three main elements which are culture, language, and social interaction. In addition, Vygotsky's theory emphasized the importance of Zone of Proximal Development (ZPD) in children's developments. Vygotsky defined ZPD as the learner's current or actual level of development and the next level attainable using mediating semiotic and environmental tools, as well as capable adult or peer facilitation.

In STEM education context, how Vygotsky's theory works is teacher needs to facilitate the children regarding to acquire information deeply. There are many beneficial ways to ensure that children can expend knowledge in understanding any topics or activities. Instead of remaining in the classroom, students are encouraged to participate in class discussions. The teacher employs a variety of learning resources, not just printed materials, and assesses students using a variety of appropriate methods (Kurniasari and Santoso, 2016). With these supports and methods, it can help the children to master something by using their own learning or scaffolding to be more precise. Scaffolding has been defined broadly and it is a metaphor developed from mother–child observations that has been adapted to a variety of contexts, including computer environments (Feyzi-Behnagh et al., 2013). Every child has different scaffolding ability and the support from his environment is important. Scaffolding techniques as various forms of adult support. Children could be encouraged to think about their own understanding before asking for help, for example, to improve the efficiency of scaffolding support.

2.5 Learning and Facilitation Process

LFP is a dynamic and critical process that allows a child to master all of the things covered in school (Yahaya et al, 2020). As a result, the implementation of LFP in the classroom must be done in a variety of ways in order to pique students' interest and keep them focused on the teacher's instruction. If seen in this context, the researchers will provide opportunities for teachers to use their creativity in implementing STEM activities with children. Although the term LFP itself brings the meaning of teacher as a facilitator, the researchers will look at the extent to which the teacher becomes a facilitator for the children when implementing the STEM activities that have been planned. This is important to ensure that teachers who teach children can apply 21st century education which allocates the teacher as a person who "facilitates" teaching and learning activities inside or outside the classroom. More intriguing is a study conducted by Anggraeni and Yusnita (2017), who assert that facing the challenges of the twenty-first century, where the teacher is no longer the sole source of information for the students, impacts the necessity to change their role from a 'dictator' to a facilitator.

If seen in the teaching class itself, teachers who do not know the best teaching practices will cause children to lack focus, lack interest, and be lazy to learn. Therefore, to ensure that LFP may be applied in an equitable and balanced manner between teachers, students, and materials, the best pedagogic and teaching practices must utilize a variety of strategies, methods, techniques, approaches, and be supported by the use of the latest resources (Goliong, Abdullah, & Talin, 2018). Teachers need to be aware of appropriate actions to ensure that the learning environment becomes more relevant to today's children. Here, the teacher's role in improving higher quality teaching needs to be implemented through STEM activities that are appropriate for their age level.

2.6 Application of the Best Practices

Experts for the country's STEM fields of the future must be polished beginning in elementary school. The Malaysian government, particularly the MOE, must take the lead in implementing entertaining, high-quality, and high-impact learning as a counterclaim against the challenges of the Industrial Revolution 4.0 (RI 4.0). Through the Sustainable Development Goals (SDGs) specifically in Goal 4.0 which is education quality allocated, it is promoting and fostering scholarly progress in order to achieve sustainable growth according to (Saini et al., 2022). This indicates that MOE must undertake initiatives that will encourage children's academic growth. For instance, integrating STEM activities into the current curriculum needs to be monitored day by day to ensure that children are learning more thorough information when they begin their studies at any early childhood education centre at the same time. In order to improve the caliber of future teachers and students, it is necessary to investigate the MOE's role in enhancing STEM activities.

Moving on, the best practice of STEM teaching can not only produce productive teachers, but it can be used as a benchmark through the guidelines provided in this study. This is because teachers in Malaysia nowadays are seen as less prepared to implement STEM activities (Jekry & Han, 2020). As a source of inspiration for early childhood education teachers (ECE teachers), the study will reveal to teachers the best practices they may use as instructors and facilitators in the classroom. This means that if teachers want to see changes in their classrooms, it must begin with the teachers themselves. From now on, careful starting efforts and preparations must be made in order to increase the quality of education used throughout time. The teacher's role now is to look at the culture of STEM education in the classroom and resolve issues that arise through the implementation of best practices from the guidelines of this study.

Last but not least, the best practices of STEM education will also be an encouragement to children to learn and indirectly, their learning performance will increase. This can be supported by a study that has been carried out by Nagac and Kalayci (2021), where they found that students' perspectives revealed that STEM education boosted their involvement in the course, that STEM education made courses more fun, and that using this education in classrooms would be beneficial for student learning. This means that the children themselves prefer to carry out STEM learning in a more cheerful way compared to the old-style ways such as the use of pencil-books, or chalk and talk sessions. This means that the children themselves prefer to carry out STEM learning in a more cheerful way compared to the old-style ways such as the use of pencil-books, or chalk and talk sessions.

■3.0 METHODOLOGY

3.1 Research Paradigm

This study is conducted by comprehending the problem statement through the examination and exploration of previous research conducted both domestically and internationally. Subsequently, the researchers determined that a suitable design should be conducted using a qualitative study employing a non-positivist methodology as shown in the Figure 2 below:

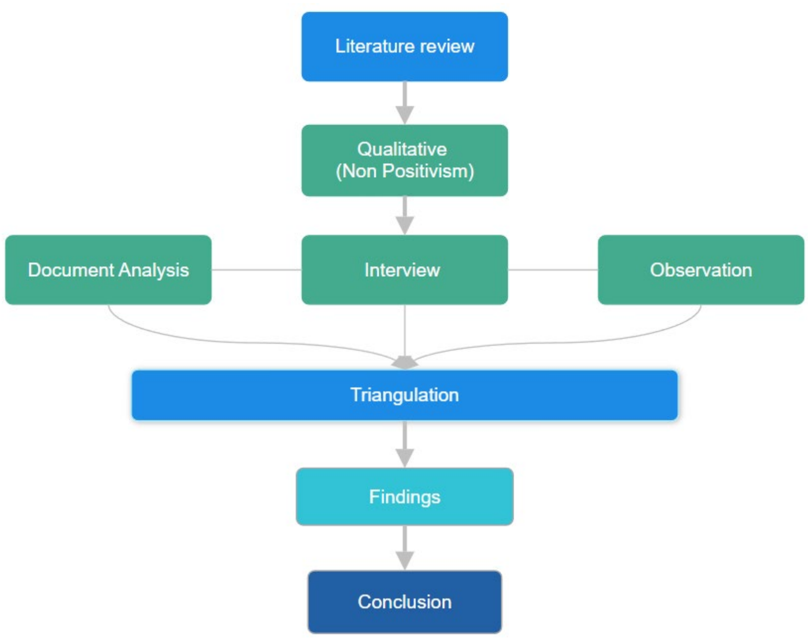

Figure 2 Research Paradigm

This study is carried out by understanding the statement of the problem through reading and exploring past studies from within and outside the country. After that, the researchers identified that the appropriate design needs to be done by using a qualitative study using a non-positivist approach. The researchers and research participants have a tight interaction under the non-positivist paradigm, although this circumstance does not exist among positivist researchers, who are frequently study participants with whom the researchers have no direct relationship. Researchers in the non-positivist paradigm likewise attempt to comprehend the significance of those who exist in the social realm. Furthermore, language plays a vital part in the construction of "reality" (Parasuraman, 2017). In this study, the researchers establish a relationship with the study participants through direct exploration, which includes two important phases of the exploration, namely interviews, observation, and analysis of the documents used throughout the teaching carried out by the study participants on children. In this investigation, a triangulation was generated from here. After collecting and analysing the triangulation data, the researchers have gotten a comprehensive examination of the coding procedures using ATLAS.ti. The researchers then derived conclusions through conversations and recommendations.

3.2 Research Design

The researchers used a qualitative design of research in this case study, as the primary objective of the researchers is to look at the results of the answer from the instruments that are formed. A case study to generalize it over several units is the focus of this study. Furthermore, to answer all the research questions, the researchers have used a focused type of case study. Cases study research is a qualitative methodology whereby an investigator uses extensive, in-depth data gathering from numerous sources of information to investigate an actual, modern binding system (a case) or many boundary systems (cases) over time and produce case descriptions and cases (Alpi & Evans, 2019). The type of case study was selected is the exploratory case study. Technically, fieldwork and data gathering might be done before formulating a research question while conducting exploratory case studies. This study could be viewed as a precursor to a larger social science study that may or may not include case studies. In addition, the type of case study selected in this research is multi-site case study because the researchers wanted to investigate phenomenon in 4 different sites. Furthermore, to ensure that the researchers obtain rich data, there were three different instruments utilised through the process of triangulation. In qualitative research, triangulation is the process of using several method or data sources to create a thorough understanding of a phenomenon (Patton, 1999). Another way to think of triangulation as a qualitative research design is as the convergence of data from several sources to test validity.

3.3 Sample and Population

Researchers used targeted sampling in this study. Judgment sampling is also known as a purposeful choice of a participant based on the characteristics of the participant. It's a non-random technique without several participants or underlying theories (Etikan, Musa, and Alkassim, 2016). In addition, there are four early childhood education teachers and 39 children that were participating in this study. The number of participants in this research can be referred as in the Table 1 below:

Table 1 Number of Participants in Each Preschool

No.	Research location	Number of teachers	Number of students
1	Preschool A	1 (SP1)	12
2	Preschool B	1 (SP2)	9
3	Preschool C	1 (SP3)	9
4	Preschool D	1 (SP4)	9

3.4 Research Instrument

Basically, the researchers have chosen to use observation as a research method. The instruments that the researchers employ to collect data are known as research instruments. Instruments are classified according to their structure or format, purpose, nature, and availability (Sathiyaseelan, 2015). There are some instruments used in this study regarding collecting the data. The instruments can be seen as in the Table 2 below:

Table 2 Research Instrument

No	Research instrument
1	Document Analysis
2	Observations
3	Interviews

3.5 Data Collection

The researchers employed three distinct instruments to gather data, following the data collection process outlined in Table 3.0. Initially, the researchers utilised observation tools to examine the exemplary teaching methods employed by teachers and the corresponding reactions of students towards these methods. Furthermore, the researchers conducted interviews with four teachers to explore the significance of STEM education and the most effective STEM education strategies implemented by two of them in their classrooms. Ultimately, the researchers scrutinised the documents collected throughout the observation and interview sessions.

Table 3 Procedure of Data Collection Timetable

NO	PROCESS
1	Permission Application
2	Work Planning
3	Collecting Assessment Form from Experts for the item validation
3	Research Tools Preparation
4	Research Time and Method of Collecting Research Data
5	Collecting Assessment Form from Experts for the data validation

3.6 Data Analysis

There are three steps taken by researchers in analysing the data. The first step is the researchers would use the transcription method. The researchers would do the process of transcribing the obtained data from interview sessions and video recordings. Then, the researchers would arrange the data after the transcription process. The data is arranged into several sections that have been reviewed and retrieved. Then, all data would be given codes and numbers to represent its contents. The third step taken by the researchers is to proceed with the coding process and determine category system. After the reading of transcriptions has successfully done, the data would be divided into several meaningful analysis units. When the meaningful segments of data traced, so it will finally be coded. Data analysis through the three steps above was done by using ATLAS.ti 8 software. This software would assist the researchers to find out text segments, putting category labels on segments and arranging texts that relate to specific categories. The details of data analysis can be seen in the Table 4 below:

Table 4 The Analysis Method for Collected Data

RESEARCH QUESTION	DATA COLLECTING	DATA ANALYZING
i. What is the best practice in early science towards the implementation of STEM activity in preschool?	Document Analysis Observations Interviews	ATLAS.ti 8
ii. What is the best practice in early Mathematics towards the implementation of STEM activity in preschool?	Document Analysis Observations Interviews	ATLAS.ti 8
iii. How do teachers include engineering activity towards the implementation of STEM activity in early childhood education?	Document Analysis Observations Interviews	ATLAS.ti 8
iv. How do teachers include engineering activity towards the implementation of STEM activity in early childhood education?	Document Analysis Observations Interviews	ATLAS.ti 8

■4.0 RESULTS

This chapter focuses on a detailed description of the findings of the research. Data were obtained through three sources which are interviews, document analysis and observations. The data obtained was analyzed using a laptop according to the Atlas.ti software's procedure. Based on four research questions in this study, there are 9 main themes recorded and analyzed to answer the four research questions (RQs).

(i) What are the best practices in early mathematics towards the implementation of stem activity in preschool?

Based on interviews, observations and document analysis conducted, researchers have found that study participants (SPs) express the importance of (ES1) collaborative learning, (ES2) learning through play, and (ES3) experimental learning. For the theme of ES1, there is one way that teachers can create collaborative activities for children which is by implementing (ES10) project -based activities. Most of the SPs have shared their experiences as STEM teachers where both practices have provided meaningful experiences for children to learn. This can be proved based on the interviews below:

> *"We did urmmm dividing to 3 habitats of animals urmmm ocean life, farm life, urmmm jungle life. So, children do it based on what we have divided. Means that, I will give, and we will change. For example, at one table, children will do the activity regarding ocean animals. Ok, let will do it themselves, and we will give them the learning tools and they will do it themselves. In that time, they will know what kinds of things in the ocean………"*
>
> ***IV - SP1***
>
> *"Watching, singing, or doing the project. Through the project approach, children can do activity together. For example, they do, they will get what they do………..."*
>
> ***IV - SP1***

In addition, for the practice of (ES2) learning through play, SPs also agreed that such activities can improve children's development and confidence to perform STEM activities. There are two types of activities in this practice that can be done by teachers namely using (ES20) learning and teaching aids and (ES20) the usage of teaching and learning aids and (ES21) following the interest of children. This can be proven by two sub-activities implemented by SP1 as below:

1. *Teacher enhances the interests of children to understand the animal life by showing off them the animal toys.*
2. *Teacher gives opportunity to children to use animal toys during exploring the animal life.*

Lesson Plan from SP1

And last but not least, the best practice that can be done when implementing STEM activities is by way of exposing (ES3) experimental learning to children. Based on the views of the teachers in the interview session, he said that (ES30) exploration encouragement was one of the most important efforts to expose the world of science to children.

(ii) What is the best practice in early Mathematics towards the implementation of STEM activity in preschool?

Most of SPs thought that three important practices that could be implemented to children are (EM1) learning through play, (EM2) entertainment influence in teaching, and (EM3) themed learning. The majority of research participants recounted their experiences as STEM teachers, describing how these practices have helped children learn in meaningful ways. During the observation session, SP3 showed that there are two efforts that can be made by an early childhood education teacher to make children play and learn greatly by exposing to children about (EM10) the usage of teaching and learning aids. First thing first, children can be exposed to play with the dough while counting. And secondly, SP3 invited all her students to participate in games-based activity on the laptop.

Next, the second practice that has been successfully recorded is (EM2) entertainment influence in teaching. In the view of majority of SPs, they believed children should be introduced to (EM20) element of singing in their learning sessions. As proof, based on the interview session, teachers argued that STEM activities through mathematics subjects would be more fun if teachers could sing with children. This can be proven through the statements below:

"If it's Mathematics, for the most part, first I'll sing. Give a song or a number or a number or like an addition. First, we introduce that learning, I will make a song first. Because of these children, they are happy to understand through songs. If we continue to teach them like putting numbers, children will not be able to."

IV- SP3

"What I do is give a song, we make it ourselves, we have a lot, we make a song, and then we ask what the number is. Or any kind of shape. All sorts of things."

IV - SP3

In addition, the researchers found that (EM3) themed learning practices are also able to improve children's cognitive skills while doing STEM activities, especially for early mathematics activities. This can be proven through the analysis documents that successfully recorded as below:

1. *Teacher can approach children to arrange objects based on the size (small to big) through power point software's games.*
2. *Teacher can guide children to count objects through power point software's games.*
3. *Teacher gives children the opportunity to match groups of objects with numbers by using real fruits.*
4. *Teacher gives opportunity to children to count numbers in tens in ascending and descending order by using the real fruits.*

Checklist for SP3

Based on the checklist above, the teacher has demonstrated a themed learning in which he has given a specific topic to the children from the beginning of the lesson to the end of the lesson. This can prove that exposure to appropriate themes is able to improve children's cognitive development well.

(iii) How do teachers include engineering activity towards the implementation of STEM activity in early childhood education?

To achieve this objective, the results show that there are only two best practices that can be done to children in improving the development of digital literacy. The first one is to introduce the child to (T1) computer-based learning and the second one is (T2) interactive visual. For (T1), there are two appropriate ways to encourage children to connect and communicate with digital literacy and it consists of (T10) the usage of hardware and (T11) the usage of software. These activities can be proven and supported statements from SPs as below:

"Ok, now it's the 21st century. That's why we use video. That's one of the tools right now. Is it usually a video or we do implement riddles on computer."

IV - SP1

"Like me myself, I made a power point, I explain the examples we have, sometimes we can explain following the book. For example, we want to teach about animals. Ok let's explain. Examples of animals in the sea, we explain what it is, we explain it to them, like the picture will come out. We will explain to them, like they will be like "wow beautiful". Before this it was just like a book. We use other things such as computers. They are happy. There're new things they will get."

IV - SP3

To support this statement, SP2 had implemented two sub-activities related to the usage of hardware based on computer-based learning which is she created a simple game on power point slides then she asked the children to move mouse within or without her guidance while completing the task. Even though this activity is seen easy, but for a few children in her class was difficult to complete the task given. But at the end of activity, children showed happy feeling because they could try their best while controlling the mouse. Next, the second-best practice that can be done to enhance children's digital literacy development is by exposing children to (T2) interactive visual. Appropriate activities that can be carried out with children are through (T20) visual display exposure. Through document analysis, namely the DSKP 2017, it has been revealed that engaging visuals can engage children to learn activities well. Through visual displays as well, it can polish children's potential to be more creative. It can be proved by the contents of the document analyzed as mentioned on the next page.

8. Information and Communication Technology (ICT)

1. *Incorporation of ICT elements in teaching and learning ensures pupils are able to apply and strengthen their knowledge and basic ICT skills.*
2. *Application of ICT motivates pupils to be creative, stimulates interest and makes teaching and learning enjoyable as well as improves the quality of learning.*
3. *ICT should be integrated based on suitability of topics and used as a tool to further enhance pupils' understanding of the subject content."*

National Preschool Standard Curriculum

(iv) How do teachers include engineering activity towards the implementation of STEM activity in early childhood education?

The results from the analysis of the study have found that there are 3 best practices that SPs can implement to increase the potential of children while doing engineering activities in preschool. The recommended practices are (E1) innovation empowerment, (E2) two ways communication and (E3) learning through play. For the practice of E1, researchers found that (E10) nurturing solving problem skills and (E11) nurturing making decision skills. Based on the views of teachers, they concluded that providing opportunities for children to make decisions and solve problems is important for the success of an engineering activity. It can be evidenced through statements from interviews conducted as below:

"life activities. Ok. Animal habitat. At that time, they will build for example, in the jungle, what is there. That means there must be something in the jungle. What's in the farm? So, they will do that thing very well. That is, through those activities, they will know. They understand."

IV - SP1

"Yes. It's important Mr. Because it has to be balanced in terms of ermmmm children, what is that? Knowledge. The reason, the reason, we have to create in engineering. Try and error. Kids can't do it, so it looks like giving up, right? Unsatisfactory. I've been through it, Mr. While doing, after I did, finally it didn't at that good, do it face to face. But the most important thing is don't give up. That's why the engineering element is a little slow compared to we do science experiments like nutrition."

IV - SP4

In addition, the second-best practice is (E2) two ways communications. Based on the analysis that has been done, teachers have agreed that the best way to increase children's interest in connecting with engineering activities is through (E20) asking and questioning directly. It means children and teachers need to ask and answer questions when conducting engineering activities independently. This can be proven through the implementation of activities by SP4 where she herself gave instructions for children to do what they are supposed to build and asked children to present what they have built. So, two ways communication happened here between teacher and children. Next, the third best practice is that SP3 introduced (E3) learning through play activity. She could raise children's awareness through (E30) the usage of teaching and learning aids. For this practice, she argued that children need to learn through their exploration on any games or tools. Researchers can identify how this exploration is effective because she does a lot of engineering activities based on exploration through play activities. This can be evidenced through daily lesson plans that has been developed by a SP4 herself as stated below:

STEP 4

(8 Minutes)

10.42am – 10.50 am

Topic: Build A city

Teacher's Action: Provides children with a variety of kinds of wooden blocks.
Children's Action: Build up a dream city with their friends.

Lesson Plan from SP4

4.1 Summary of Findings

The Figure 3 as shown in the next page shows a complete set of themes of the best practices that were successfully recorded, arranged, organized, and analyzed using ATLAS.ti version 8 through interview sessions that were successfully conducted on four study participants, observations in the classroom to see the how the teachers conduct the activities, and documents analyzed in preschool and also based on past studies. These 9 recommended practices are not confined to one session of teaching, but they can be utilized in a variety of other lessons. For example, question and answer activities can be done not only for engineering activities, but also for other STEM activities such as early mathematics or early science. To see what the 9 best practices are successfully resulted in the best teaching and facilitation sessions done by four different teachers, it can be referred to the Figure 3.

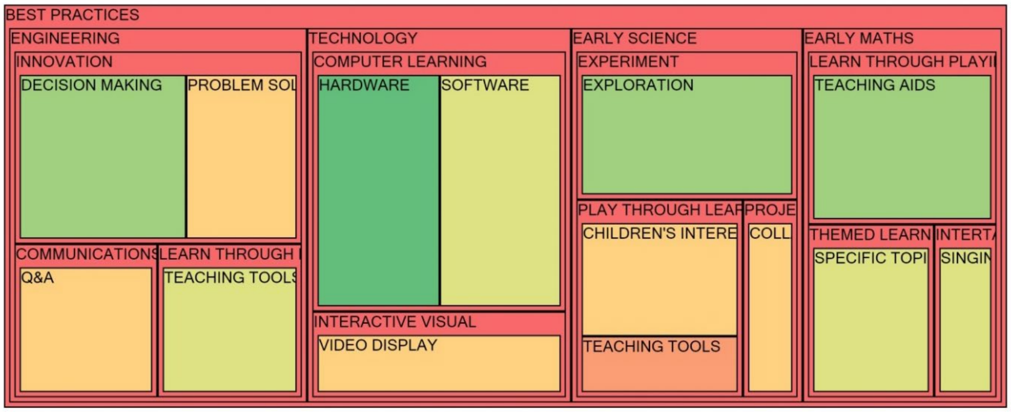

Figure 3 The Best Practices Successfully Organized by Relevant Themes

In addition, the analysis conducted on four SPs in the field of early childhood education explained that all of them had agreed on the use of DSPK 2017 in their teaching. The DSPK 2017 has become a reference for them to teach children about any activity involving STEM education. Although they come from private preschool-based backgrounds, they still follow the guidelines recommended by the MOE which is the use of DSPK 2017 as the main reference for planning and implementing activities in the classroom. Moreover, they had agreed that fair teaching to children regardless of any differences through STEM education should be done in preschool. This can be evidenced through the consensus of all participants who stated that STEM activities will be taught to all children fairly and this situation has directly supported MOE's efforts in shaping superior education through STEM education. Based on this study, there are several best practices that have been recorded by the researchers. This means that every teacher can make their reference when implementing STEM activities in the future. To ensure that it can be seen clearly, the researchers has included each of these practices as in the Table 5 below:

Table 5 Analysis of the Themes for the Best Practices of STEM Education

No.	Research Questions / Best Practices	RQ1	RQ2	RQ3	RQ4
1.	Learn through play	/	/		/
2.	Experimental learning	/			
3.	Collaborative learning	/			
4.	Entertainment influence in teaching		/		
5.	Themed learning		/		
6.	Computer-based learning			/	
7.	The use of interactive visual			/	
8.	Innovation empowerment				/
9.	Two ways communication				/

The Table 5 above shows that the researchers successfully found out that there are 9 best practices that have been recorded throughout the analysis phases of the study conducted. Among all these practices, the researchers found that the practice of learning through play is the practice that most teachers apply in their teaching for different activity or project. From four analysis made, 3 teachers namely T1, T3 and T4 have implemented the practice of learning through play in their STEM teaching. There are many elements used in applying this practice such as the use of teaching materials and also teachers provided free space for children to play. In addition, to ensure that the practices formed can be adopted for future studies and be referred as the guidelines for various parties, the researchers have used the expertise of four early childhood education experts in the field of STEM in order to confirm whether the best practices formed are acceptable or not. Based on the results based on the results from Cohen's Kappa statistical, all of them agreed that the 9 main themes in this study were accepted as best practices for the implementation of STEM activities in early childhood education centers, especially preschools. It can be referred to the Figure 4 as below:

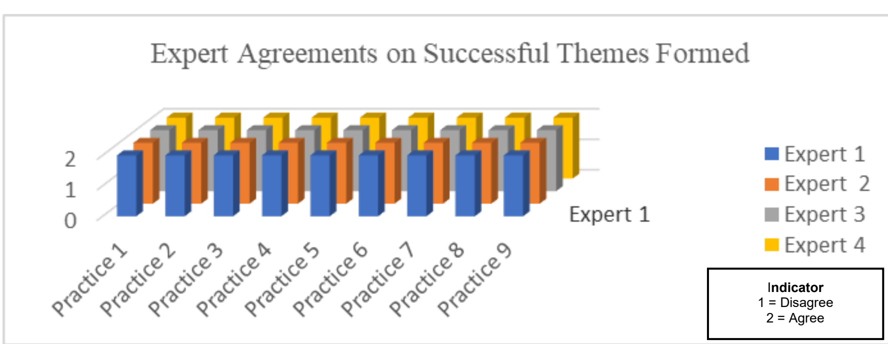

Figure 4 Analysis of the Expert Agreements on Successful Practices Formed

■5.0 DISCUSSION AND RECOMMENDATION

Based on the results of the study, most of the participants had given their respective ideas on what are the appropriate practices in improving the teaching of early science through STEM Education. The first best practice which can be practiced by preschool teachers is by choosing project-based teaching. This is because the involvement of children in project activities can encourage them to share ideas with friends. According to Balemen and Özer Keskin (2018), in science education, project-based learning has been demonstrated to be 86 percent more successful than traditional teaching methods. As a result, project-based learning should be used often in scientific classes at all levels of education. Diverse learners in this study included children with special needs, children with problematic behaviors, and children who came from homes where they were at risk of academic failure. One of the study participants emphasized the idea twice that group learning is very important to enable children to perform activities or tasks assigned by the teacher. If we look from the point of view of preschool, group learning can be implemented in various ways and one of the best efforts is through the teacher's approach in giving children the opportunity to learn together with their peers.

In addition, there are three best practices that can be practiced by teachers in implementing early mathematics activities through STEM Education. These practices had been recommended by teachers where it can make it easier for teachers when teaching children about early concepts of mathematics. The first practice is that the teacher had explained specifically about the practice of giving children the opportunity to learn through play is able to give them to explore their world in more depth. Based on the research conducted by Ashari et al, (2015), children's play gives them with opportunity to express their emotions and enhance their self-confidence and self-esteem. Introducing cooperative cognitive play to preschoolers can help them develop socially and intellectually. Besides that, Through the findings of a study using interview, observation, and document analysis methods, researchers have identified that the best practice of STEM teaching through the integration of technological disciplines is to use a digital learning approach. The digital learning can give children the opportunity to explore their world using computers. They are not only able to learn to use computers, but they will also become more knowledgeable through the experience of accessing information through computers. Learning modules that include computer-based learning techniques, approaches, and elements such as computer animations and visuals, can accommodate most or all learning styles. The use of a variety of technological tools in learning and teaching can assist students in receiving the finest possible education and timely feedback (Basuhail, 2020). It is widely accepted that children learn more quickly in an engaged and functional learning environment. Perhaps the most important advantage of computer-assisted training over traditional instruction is that it saves time.

Finally, the field of engineering is one of the important disciplines in the early development of children. Through the findings of the study, there are three best practices to ensure that teachers' teaching and learning can be implemented well. The first practice is to empower innovation in teaching. According to participants in the study, to facilitate children to understand engineering concepts, children's thinking skills need to be improved. According to National Research Council (2012), because the fundamental purpose of engineering is to solve problems that originate from a specific human need or desire, engineering design has garnered significant attention as a crucial component in science, technology, engineering, and mathematics (STEM) education. Engineers use their knowledge of physics and math, as well as their understanding of the engineering design process, to accomplish this. Through the observations made, there are two skills that had been focused on by teachers in encouraging children to create which are problem solving skills and decision-making skills.

Moving on to recommendation part, in ensuring children get engaged with STEM learning, teachers need to take some of the best steps to ensure children acquire information through quality learning. In preschool, children not only come to learn science, technology, engineering, and mathematics based on observations on whiteboards, writing in books, or memorizing certain themes and concepts, but they need to diversify their development based on experience from exploring the surroundings. At this stage, teachers need to provide active and fun learning to children through learning from STEM Education activities. This is in line with the concept that were emphasized by Dewey (1986) which he stated that "providing the students with enjoyable learning experiences motivates them to continue learning and this motivation matters just as much as knowledge that is learned".

In terms of teaching methodology or implementation, teachers can diversify STEM teaching by using a variety of methods. As has been suggested by Mpofu (2019) where there are four ways that teachers can use in implementing STEM activities in schools. An example that can be implemented by teachers is by combining STEM disciplines in one lesson. For example, teachers teach children early science activities, and there are three other elements such as math, technology, and engineering. In addition, teachers can also segregate STEM teaching based on specific discipline such as the use of technology in Science or Mathematics activities. This is because, in order to produce 21st century learning, teachers need to cultivate STEM elements to be able to teach something.

The researchers suggested that the government especially the MOE should increase the promotion of STEM Education through its implementation in Malaysian preschools and other early childhood institutions. This is because the role of education policy makers can create progress in the Malaysian Education system in line with the government's expectations previously in focusing on STEM Education at an earlier stage. This suggestion can support the statement explained by Daud (2019), which she stated that MOE mentioned that STEM education aims to combine all areas of STEM knowledge in the teaching and learning process starting from the school level to cultivate the interest of the current generation in pursuing the field of STEM education. To ensure that this target can be formed, the MOE needs to take several appropriate initiatives to ensure that children can obtain quality learning when they are in preschool. On the other hand, the connection between the policies of MOE and the implementation of STEM education from teacher is important to bridge the gap to advance the Malaysian Education System. To bridge the gap, teachers first need to be aware of the importance of STEM education. According to Shen (2015), it is necessary for authorities to raise awareness among STEM teachers. Teachers who are aware of the relevance of STEM will be motivated, which will have an indirect effect on student motivation and participation in STEM activities. Besides that, based on the findings of research, teachers' understanding of how to introduce STEM into the classroom is limited. This could be due to a lack of information from the authorities.

■6.0 CONCLUSION

Overall, the results of this study have successfully answered the research questions. Based on the results of the study findings that have been discussed, it can be summarized and finally put forward some recommendations and implications. Researchers argue that to ensure that STEM education can be carried out well, a stronger STEM model needs to be provided to early education teachers whether preschool, nursery, or preschool teachers so that the implementation of STEM teaching can be carried out well. The usage of learning modules as teaching and learning materials also allows curriculum creators to look for alternatives to using existing textbooks in developing excellent R&D resources that are relevant to current needs countries. Therefore, all efforts need to be stepped up to ensure that the initial goals are achieved. But all efforts will be in vain if not accompanied by positive values and attitudes and always make improvements to the existing system. Finally, hopefully the results of this study can trigger a collective collaboration to create a reference for STEM education practices at an early stage with a more comprehensive, robust, and effective under the leadership of the MOE. Researchers believe that if teachers can apply the goals set by the government in ensuring that STEM education can be developed in schools, then our country can produce the best leaders in the future. Building children' abilities, content knowledge, and literacy in STEM fields is critical if we want a nation where our future leaders and workers can grasp and solve some of today's and tomorrow's challenging challenges, as well as fulfil the expectations of a dynamic and evolving workforce (U.S Education Department, 2021).

Acknowledgement

I express my gratitude to those individuals with whom I have had the privilege of collaborating on this and other associated endeavors. Every member of my Thesis Committee has offered me substantial personal and professional mentorship, imparting valuable knowledge about scientific research and life in general. Furthermore, I would like to express my sincere appreciation to Sultan Idris Education University Education and the University of Technology Malaysia for their kind provision of numerous resources during the composition of this paper. Not to be forgotten, thank you UTMNexus Scholarship for assisting me financially throughout the completion of this paper.

References

Abdul Rahman, N. M. (2015). *Construction of Modules Based on the Project Approach to improve the communication skills of kindergarten students* [Doctoral Dissertation, Universiti Sains Malaysia].

Adam, N. A., & Halim, L. (2019). The challenge of integrating STEM education in the Malaysia curriculum. *Seminar Wacana Pendidikan (September): 1–10.* UKM, Selangor: Malaysia. Retrieved on January 1st, 2023, from https://myjms.mohe.gov.my/index.php/jdpd/article/view/10573

Aldemir, J., & Kermani, H. (2017). Integrated STEM curriculum: Improving educational outcomes for Head Start children. *Early Child Development and Care, 187*(11), 1694–1706. https://doi.org/10.1080/03004430.2016.1185102

Alpi, K., M, & Evans, J., J. (2019). Distinguishing case study as a research method from case reports as a publication type. *Journal of the Medical Laboratory Association, 107*(1), 1 – 5. https://doi.org/10.5195/jmla.2019.615

Amran, M.S., Abu Bakar, K., Surat, S., Mahmud, S.N., & Mohd Shafie, A.A. (2021). Assessing Preschool Teachers' Challenges and Needs for Creativity in STEM Education. *Asian Journal of University Education*, 17(3), 100-108. https://doi.org/10.24191/ajue.v17i3.14517

Ashari, Z. M., Azlina, K., and Jiar, Y. K. (2015). Construction of learning through play module in early Mathematics learning of preschool children. *Conference: INSAN 2015,* 1-8.

Babakr, Z. H., Mohamedamin, P., & Kakamad, K. (2019). Piaget's cognitive developmental theory: Critical review. *In: Education Quarterly Reviews, 2(*3), 517-524. https://doi.org/10.31014/aior.1993.02.03.84

Balemen, N., & Özer Keskin, M. (2018). The effectiveness of Project-Based Learning on science education: A meta-analysis search. *International Online Journal of Education and Teaching (IOJET), 5(*4), 849-865. http://iojet.org/index.php/IOJET/article/view/452/297

Basuhail, A. A. (2020). Application of learning objects for computer programming-based problem solving. *Canadian Journal of Leaning and Technology, 46*(1), 1-15. https://files.eric.ed.gov/fulltext/EJ1267478.pdf

Campbell, C & Speldewinde, C. (2018). *Bush kinder in Australia: a new learning 'place' and its effect on local policy, Policy futures in education, 17*(4), 541-549. https://doi.org/10.1177/1478210317753028

Curriculum Development Division. (2016). *Buku Penerangan Kurikulum Standard Sekolah Menengah (KSSM)*. Putrajaya: Ministry of Education. Retrieved on January 1st, 2022, from http://smksyedsira.edu.my/wp-content/uploads/2016/12/2.-Buku-Penerangan-KSSM.pdf

Daud, K. (2019). The challenges of preschool teachers in implementing STEM education. *Journal of Science & Mathematics Education Malaysia 9*(2), 25-34. https://doi.org/10.37134/jpsmm.vol9.2.4.2019

Dewey, J. (1897*).* My Pedagogy Creep*. School Journal, 54*, 77-80. Retrieved on January 1st, 2023 at http://playpen.meraka.csir.co.za/~acdc/education/Dr_Anvind_Gupa/Learners_Library_7_March_2007/Resources/books/readings/17.pdf

Dewey, J. (1986). Experience and education. *The Educational Forum, 50*(1), 241 – 252. DOI.org/10.1080/00131728609335764

Early Childhood STEM Working Group (2017). Early stem matters: providing high-quality STEM experiences for all young learners. A policy report by early childhood STEM working group. Retrieved on September 7th, 2021, from http://ecstem.uchicago.edu.

Etikan, I. l., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Feyzi-Behnagh, R., Azevedo, R., Legowski, E., Reitmeyer, K., Tseytlin, E., & Crowley, R. (2013). Metacognitive scaffolds improve self-judgments of accuracy in a medical intelligent tutoring system. *Instructional Science, 42(2),* 159–181. https://doi.org/10.1007/s11251-013-9275-4

Hoachlander, G., & Yanofsky, D. (2011). Making STEM real: By infusing core academics with rigorous real-world work, linked learning pathways prepare students for both college and career. *Educational Leadership, 68*(3), 60–65. https://www.headroyce.org/uploaded/ Library/MakingSTEMReal.pdf

Isabelle, A. D., & Valle, N. Z. (2016). Inspiring STEM Minds: *Biogra-Phies and Activities for Elementary Classrooms.* Rotterdam, WA: Sense Publishers.

Jekri, A., & Han, C. G. K. (2020). The challenges in implementing STEM teaching and learning in secondary schools. *International Journal of Education, Psychology and Counseling, 5*(34), 80-90. https://doi.org/10.35631/IJEPC.534006

Johnson, C. C., Mohr-Schroeder, M. J., Moore, T. J., & English, L. D. (Eds.). (2020). *Handbook of research on STEM education* (1st ed.). Routledge.

Kurniasari, A. I., & Santoso, A. (2016). The teacher's roles in supporting the ZPD in the students' English oral communication skills based on the PYP language scope and sequence of grade ey 3a: a case study. *A Journal of Language, Literature, Cultural, and Education, 12*(2), 1-23. https://doi.org/10.19166/pji.v12i2.362

Lange, A. A., Brenneman, K., & Mano, H. (2019). *Teaching STEM in the preschool classroom: Exploring big ideas with 3-to 5-year-olds*. New York: Teachers College Press.

Ministry of Education Malaysia. (2019). National Education Philosophy. Retrieved on November 7th, 2023, from https://www.moe.gov.my/index.php/dasarmenu/falsafah-pendidikan-kebangsaan

Ministry of Education Malaysia. (2016). *National Preschool Standard Curriculum 2017*. Putrajaya: Curriculum Development Section

Ministry of Education of Malaysia (2013). *Malaysia Education Blueprint 2013 – 2015 (Pre School – Post- Secondary Education)*. Putrajaya, Malaysia: Ministry of Education. Retrieved on January 1st, 2023 from https://www.moe.gov.my/menumedia/media-cetak/penerbitan/dasar/1207-malaysia-educationblueprin t -2013-2025/file

Ministry of Finance Malaysia. (2014). *Budget of 2014*. Putrajaya: Ministry of Finance Malaysia. Federal Government Administrative Centre.

Ministry of Finance Malaysia. (2022). *Budget of 2023.* Putrajaya: Ministry of Finance Malaysia. Federal Government Administrative Centre.

Ministry of Housing and Local Governance Malaysia. (2017). National Transformation 2050. Retrieved on November 5th, 2023, from https://www.kpkt.gov.my/index.php/pages/view/577

Misdi, N., Sumintono, B., & Abdullah, Z. (2019). Mara College Teacher Leadership: A Case Study. *Jurnal Kepimpinan Pendidikan, 8(*2), 46-63. https://www.researchgate.net/publication/33436186 7_Kepemimpinan_Guru_Kolej_MARA_Satu_Kajian_Kes

Mitleer, R. M., Ginsburg, K. R., Council on Communications and Media., & Committee on Psychosocial Aspects of Child And Family Health. (2012). The importance of play in promoting healthy child development and maintaining strong parent-child bond: focus on children in poverty. *Pediatrics, 129* (1), 204–213. https://doi.org/10.1542/peds.2011-2953

Mohammud, M. N., Ismail, N. I., Fohimi, N. A. M., Sharudin, H., & Rampisela, T. P. H. (2020). Design and develop STEM Education in Malaysia: A Downdraft Gasifier Model. *International Journal of e-Learning and Higher Education, 14*(1), 5-15. https://ir.uitm.edu.my/id/eprint/65933/1/65933.pdf

Mohd Hawari, A., & Mohd Noor, A. (2020). Project based learning pedagogical design in STEAM Art Education. *Asian Journal of University Education,16*(3), 102-111. https://doi.org/10.24191/ajue.v16i3.11072

Moore, T. J., Johnson, C. C., Peter-Burton, E. E, Guzey, S. S. (2016). STEM *Road Map: A Framework for Integrated STEM Education*.13-22. NY: Routledge Taylor & Francis Group

Moreno, R. (2010). *Educational Psychology*. Hoboken, NJ: John Wiley & Sons, Inc.

Morgot. K. C., & Kettler. T. (2019). Teachers‟ perception of STEM intergration and education: A systematic literature review. *International Journal of STEM Education*, 6(2), 1-16. https://doi.org/ 10.11 86/s40594-018 -0151-2

Mpofu, V. (2019). A Theoretical Framework for Implementing Stem Education. Theorizing STEM Education in the 21st Century. Retrieved on December 3rd, 2022, from https://www.intechopen.c om /books/theorizing-stem-education-in-the-21st-century/a-theoretical-framework-for-implementing-stem-education. https://doi.org/10.5 772/I ntechopen.88304

Murphy, S., MacDonald, A., Danaia, L., & Wang, C. (2019). An analysis of Australian STEM education strategies. *Policy Futures in Education*, *17*(2), 122–139. https://doi.org/10.1177/1478210318774190

National Research Council (NRC). (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering and mathematics.* Washington, DC: The National Academic Press.

National Research Council [NRC]. (2012). *A framework for K-12 science education: Practices, cross cutting concepts, and core ideas*. Washington, DC: The National Academies Press.

Pantoya, M., Hunt, E., & Aguirre-Munoz, Z. (2015). Developing an engineering identity in early childhood*. American Journal of Engineering Education, 6*(2), 61–68. https://doi.org/10.19030/ajee.v6i2.9502

Parasuraman, B. (2017). Perdebatan kajian sains sosial: Pengalaman penyelidik. *Jurnal Kemanusiaan, 9*(2), 47-58.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research, 34*(5 Part 2), 1189-208.

Piaget, J. (1963). *The Origins of Intelligence in Children*. New York: W. W. Norton

Rahayu, T., Syafril, S., Othman, K. B., Halim, L., & Erlina, N. (2018). Kualiti Guru, Isu Dan Cabaran Dalam Pembelajaran STEM. Retrieved on May 15th, 2022, from https://doi.org/1010.31219/osf.io/jqcu6

Razak, N. (2017). *Falsafah Asas TN50.* Malaysia, Shah Alam: Yayasan Penyelidikan Transformasi.

Richer, E., Brunner, M., & Richer, D. (2021). Teacher educators' task perception and its relationship to professional identity and teaching practice. *Teaching and Teacher Education, 101*. https://doi.org/10.1016/j.tate.2021.103303

Sathiyaseelan, M. (2015). Research instruments*. Indian Journal of Continuing Nursing Education, 16 (2)*, 57-60. https://www.ijcne.org/downloadpdf.asp?issn=22307354;year=2015;volume=16;issue=2;spage=57;epage= 60; aulast=Sathiyaseelan;type=2

Shen, B., McCaughtry, N., Martin, J., Garn, A., Kulik, N., & Fahlman, M. (2015). The relationship between teacher burnout and student motivation. *British Journal of Educational Psychology, 85*(4), 519–532. https://doi.org/10.1111/bjep.12089

Sikandar, A. (2015). John Dewey and his philosophy of education. *Journal of Education and Educational Development 2*(2), 191 – 201. https://doi.org/10.22555/joeed.v2i2.446

Sigelman, C. K., & Rider, E. A. (2012). Life-Span Human development. Belmont, USA: Wadsworth, Cengage Learning.

Sneiderman, J. M. (2013). *Feature Story.* Washington, DC: North American Association for Envimental Education.

Telebi, K. (2015). John Dewey - Philosopher and Educational Reformer. *European Journal of Education Studies, 1(*2), 1-13. https://doi.org/10.6084/m9.figshare.2009706

Topçiu and Myftiu. (2015). Vygotsky theory on social interaction and its influence on the development of pre-school children. *European Journal of Social Sciences Education and Research, 2*(3), 172-179. https://doi.org/10.26417/ejser.v4i1.p172-179

U.S Department of Education. (2021). Science, Technology, Engineering, and Math, including Computer Science. Retrieved on November, 17th 2021 from https://www.ed.gov/stem

Wan, Z. H., Jiang, Y., & Zhan, Y. (2020). STEM education in early childhood: A review of empirical studies. *Early Education & Development, 32*(7), 940-962. https:// doi. org/ 10. 1080/ 10409 289. 2020. 18149 86